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one sixth of the present market price, and give promise of an ultimate low price of a fraction over two cents per gallon. The result is secured by purely mechanical means, without an atom of added chemicals. Atmospheric air is first purified and then compressed by stages to 2,500 pounds to the square inch. It is finally reduced to 125 pounds to the square inch, which then cools and liquefies the high-pressure air. The oxygen gas produced by separating the nitrogen from the liquid air is claimed to be purer than that of the old method, and can be supplied in the liquid as well as in the gaseous form. One gallon of liquid air equals approximately 128 cubic feet of oxygen gas, which retails at six cents per cubic foot. The new price is one cent. Liquid air has been successfully used in coal as an explosive, being quite safe where fire damp and other explosive gases exist. Liquid oxygen is also used for welding steel pipes, boiler shells and plates for shipbuilding instead of riveting. That oxygen and nitrogen can be separated from liquid air and sold retail at \$1.20 per gallon shows great commercial possibilities. The use of nitrogen for agricultural purposes opens yet another field. The maturing of liquors will be helped by liquid air, as also the preservation and purification of milk. As a motive power its use is considered to be quite practicable for small powers. The British government is already carrying out a number of experiments with a view to the utilization of liquid air for various purposes.

RADIUM.¹

I venture to think that the thanks of the public are due to Lord Kelvin for his timely and outspoken protest against the conclusion being drawn, from the evidence at present before us, that it is proved that there is a 'gradual evolution of one element into others.' No one has yet handled 'radium' in such quantity or in such manner that we can say what it is precisely. That

helium can be obtained from 'radium' appears to be proved; but no proof has yet been given that it is not merely contained in it. As I remarked at York last week, physicists are strangely innocent workers; formulæ and fashion appear to exercise an all-potent influence over them. There was a time when the expression 'scientific caution' meant the highest degree of caution, and it was supposed to be the attribute of workers in science. Workers in the radium school appear to have cast caution to the winds and to have substituted pure imagination for it. Among ourselves, we should always be at liberty to postulate the most crack-brained of hypotheses, to dream the wildest of dreams, as a means of guiding inquiry; but we should not court popularity on such a basis. By so doing we lose all claim to guide public opinion.

HENRY ARMSTRONG.

I am glad to have contributed towards eliciting Lord Kelvin's views on this subject. Those interested will no doubt judge for themselves whether or not the precautions adopted by Ramsay and Soddy, Himstedt and Meyer, and Curie were such as to make it certain that helium is continuously evolved from radium, as those writers supposed.

As to the internal heat of the earth, Lord Kelvin quotes the generally accepted conclusion that the life of radium is limited to a few thousand years. From this he argues that the radium now in existence has not been there long enough to heat the earth to its present high internal temperature. To this I reply that it is true that the actual radium now in existence has not done the work throughout, but that the supply of radium in the earth is maintained at a constant level by the production of fresh radium by uranium, contained in a small proportion in the rocks. Lord Kelvin, anticipating this reply, expresses his dissent from the view, current among workers on radioactivity, that radium is continuously produced by uranium. I should like to ask a simple question. Lord Kelvin disbelieves that radium is being generated from any parent substance. How does he explain the existence of radium in the earth at present? On his own showing the identical radium now existing has not been there long. Is he prepared to assume that it was miraculously created in comparatively recent times?

R. J. STRUTT.

¹ Correspondence in the *London Times*, called forth by a letter from Lord Kelvin, reprinted in the issue of *SCIENCE* for August 24, p. 255.

In your yesterday's issue I see letters of Sir Oliver Lodge and Mr. R. J. Strutt, replying to

my letter to you of August 9 regarding radium.

After a kind personal reference to myself, Sir Oliver Lodge says, "but it is also known that" Lord Kelvin's mind "has not always submitted patiently to the task of assimilating the work of others by the process of reading, and our hope has been that before long he would find time and inclination to look into the evidence more fully." I am quite sure my old friend Lodge could not wilfully be unjust to me, but I do not think he knows how carefully and appreciatively I have done all I could by reading, and by personal intercourse with many of the chief workers in the field, to learn experimental results and theoretical deductions regarding radioactivity, ever since its discovery ten years ago by Henri Becquerel. I scarcely think any other person has spent more hours in reading the first and second editions of Rutherford's 'Radioactivity' than I have.

Both Lodge and Strutt refer to the slowness of the extraction of helium from radium, in the process hitherto followed; and there seems to be good reason to believe that this slowness is essential. Strutt says, "If all helium has been removed from a sample of radium, it is found that, after an interval, a further supply can be extracted." The last clause shows that the initial 'if' was wrong; and that some helium remained in the modified sample of radium. This view is thoroughly in accordance with Rutherford's second edition (1905), p. 284, in which it is suggested that 'uranium, thorium and radium are in reality compounds of helium'; and, more particularly, that radium (atomic weight 225) may be a compound of four atoms of helium (atomic weight 4×5) and one atom of lead (atomic weight 205).

As to the suggestion, made first, I believe, by Sir George Darwin about three years ago, and favorably received by Rutherford, Strutt and others, that our present underground heat, and sun-light and sun-heat are due to radium, I must, for the present, limit myself to two sentences:

(1) Radium alone is quite insufficient, its duration as a source of energy being estimated by Rutherford (2d edition, p. 458) as not more than a few thousand years ('the average life of radium is 1,800 years'). (2) The suggestion that in uranium, thorium, actinium and other matter capable of being 'transformed slowly into radium,' we have at least a million times as great a store of energy as we may think we have in radium, practically available for sun-heat and underground heat, is not validly supported by any experimental evidence hitherto published.

KELVIN.

Your leading article (August 18) and recent correspondence show that an emphatic statement is needed to make clear to your lay readers:

(1) That radium is not an ordinary chemical compound.

(2) That it does disintegrate with explosive violence.

(3) That it is present in sufficient quantity to account for the heat of the earth.

(4) That its disintegration is not altered by any known physical conditions.

Some experimental results obtained by me last spring at Montreal, under the guidance of Professor Rutherford, are in good agreement with those found independently and by a different method by the Hon. R. J. Strutt. The equivalent amount of radium present in the upper layers of the earth was determined by the penetrating radiation resulting from the active matter. An account of this work has been communicated to the *Philosophical Magazine* and is in the printer's hands.

It is certain that radium does occur in sufficient quantity, and that its heat energy is of sufficient magnitude, to account for the existing temperature-gradients of the earth. Until we can conduct experiments in the interior of the earth, the radium theory is entitled to at least as much weight as the gravitation theory.

The recent discussion in your columns has resulted in a goodly crop of errors, written by those who have contented themselves with reading rather than with research work. I believe that no actual worker at the subject dissents from the general conclusions contained in Rutherford's 'Radioactivity.'

For example, it has been implied that radium is merely an ordinary compound of lead (?) and helium. But no ordinary chemical compound projects a particle, having the mass of a helium atom, with a velocity almost of the order of the velocity of light.

It has been stated that the disintegration of radium occurs too slowly to be detected by direct observation, and that is true. But some of the other active bodies, such as the subsequent products of radium, disintegrate with no less violence in a few minutes. It has been suggested that the disintegration may be retarded by pressure or by lack of concentration; but all the evidence—and there is much—indicates that the process of disintegration can neither be accelerated nor retarded by temperature, pressure, concentration, or other physical changes.

It is to be hoped that reverence for a great name and an honored veteran will not induce your readers to regard lightly the brilliant and remarkable series of recent scientific discoveries in radioactivity.

A. S. EVE.

SCIENTIFIC NOTES AND NEWS.

DR. JOSÉ DE AGUILAR, director of the Mexican Geological Survey, has been elected president of the International Geological Congress, which met last week in Mexico City.

SIR DAVID GILL, astronomer royal at the Cape of Good Hope and president-elect of the British Association for the Advancement of Science, has been elected a foreign member of the Accademia dei Lincei, Rome.

DR. OTTO BÜTSCHLI, professor of zoology at Heidelberg, has been elected a foreign member of the Brussels Academy of Sciences.

IN connection with the celebration of the quater-centenary of the foundation of the University of Aberdeen, the University of St. Petersburg has conferred its honorary membership on the lord rector, Sir Frederick Treves, the eminent surgeon and anatomist.

DR. EDOUARD ZELLER, the eminent writer on the history of philosophy, celebrated on August 25 the seventieth anniversary of his doctorate.

DR. JOHANN RANKE, professor of anthropology and general natural history at Munich, has celebrated his seventieth birthday.

PROFESSOR R. B. DIXON, of Harvard University, has completed an ethnological and philological exploration of the Chimariko Indians of California in connection with the Ethnological and Archeological Survey of California. The Chimariko constitute the Indian stock which is nearest to extinction of the many in California, and Professor Dixon found only four or five survivors. He was able to obtain particularly full information as to the language.

MAJOR RYDER, R.E., who had charge of the expedition to Gartok and western Tibet after the capture of Lhasa, has returned to India, where he has been appointed superintendent of the northern circle of frontier surveys.

THE annual course of Lane medical lectures was given in Cooper Medical College, San Francisco, by Dr. John McVail, Glasgow, Scotland, on August 20 and the five following days. The general subject of the lectures was 'The Prevention of Infectious Diseases.'

DR. G. WOBERMIN, who has recently been called from Berlin to an associate professorship at Marburg, will give a course of lectures at Yale University on 'German Culture in the Nineteenth Century.'

WE have already noted the movement in Germany to raise a memorial fund for the benefit of the widow and children of the late Dr. Schaudinn. We learn from *Nature* that an English committee consisting of Professor Clifford Allbutt, F.R.S., Sir Michael Foster, F.R.S., Mr. Jonathan Hutchinson, F.R.S., Professor Ray Lankester, F.R.S., Sir Patrick Manson, F.R.S., Professor Osler, F.R.S., Mr. John Tweedy and Professor Sims Woodhead has been formed to cooperate with the German promoters of the scheme. Subscriptions may be paid to Mr. Adam Sedgwick, F.R.S., treasurer of the fund, New Museums, Cambridge, or direct to the Schaudinn Memorial Fund at Messrs. Barclay and Company's Bank, Cambridge. American subscriptions would doubtless be welcome.

DR. H. MARSHALL WARD, F.R.S., professor of botany at Cambridge University, died on August 26, aged fifty-two years. Professor Ward, who was educated at Owen's College and Cambridge University, was for a time cryptogamic botanist to the Ceylon government; in 1883 he was elected to a fellowship at Christ's College at Cambridge, and after working as professor of botany in Forest School, Coopers Hill, from 1885 to 1895, he succeeded the late Professor C. C. Babington as professor of botany in Cambridge University. Dr. Ward was the author of works on the diseases of plants, and especially of timber trees.

DR. ALEXANDER HERZEN, professor of physiology at Lausanne and the author of numerous contributions to this science especially con-